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Differential Participation of Graduate Men and Women in Two Scientific Communities of Practice

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Abstract

In this paper the differential participation of men and women in scientific communities of practice was examined in two graduate science departments. Data from a survey questionnaire and interviews with graduate students and faculty members were used to examine students' level of participation in their community of practice. Within each department, vital areas were identified which either limited or facilitated students' participation. Collaboration among the members of research teams, collegiality among research groups, and diversity within the academic and student bodies facilitated students' participation at various levels. In contrast, competition, lack of collaboration, and lack of collegiality and diversity, limited students' participation in their communities of practice.

Keywords: Women, Men, Scientific communities of practice, graduate student participation

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Introduction

Investigators of organizational culture contend that organizations can be conceived as cultures. According to Morgan (1997), organizations as cultures "focus on the values, ideas, beliefs, norms, rituals, and other patterns of shared meaning that guide organization life" (p. 7). A number of researchers have applied the concept of organizational culture in their study of academic life (Aguirre, 2000; Cohen, 1993; Folch & Ion, 2009). However, few researchers have used this concept in the study of departments within large universities. In research universities every Ph.D. granting department sets its policies for recruitment, admission, and curriculum requirements (Hirt & Muffo, 1998; Office of Scientific and Engineering Personnel, 1996; Schuh & Kuh, 2005). Quantitative studies on graduate student attrition indicate that the department is the best unit of analysis when predicting graduate student completion rates (Berg & Ferber, 1983; Nettles & Millet, 2006; Girves & Wemmerus, 1988). According to Girves and Wemmerus (1988):

> The department characteristics directly influence doctoral degree progress. The norms and expectations of the faculty vary by department. The nature of the department, including the attitudes of the faculty and the activities that they value and engage in determine, in part, the kind of experience that a graduate student has. (p.186)

MacGilchrist, Mortimore, Savage and Beresford (1995) defined culture as "the procedures, values, and expectations that guide people's behavior within an organization" (p. 36). Similarly, Schein (1992) contended that culture comprises "the deeper level of basic assumptions and beliefs that are shared by members of an organization, that operate unconsciously, and that define in a basic 'taken-for-granted' fashion an organization's view of itself and its environment" (p. 3). These definitions imply that culture is "logical, coherent, shared, uniform, and static" and portray culture as if it were a "concrete and bounded body of beliefs and practices," (Sewell, 1999, p. 39; 44). Yet a number of researchers contend that cultural understandings and beliefs are not equally shared among the members of a culture (Cole & Engestrom, 1993; Habrowski & Maton, 2009; Lemke, 1994; Sewell, 1999). As Cole and Engestrom (1993) pointed out:

> There is no doubt that culture is patterned, but there is also no doubt that it is far from uniform, because it is experienced in local, face-to-face interactions that are locally constrained and, hence, heterogeneous with respect to both "culture as a whole" and the parts of the entire cultural toolkit experienced by any given individual. (p. 15)

In view of its contextual nature, culture is best understood "as practice" or "as a category of social life" (Sewell, 1999, p. 40). In this framework culture is viewed as "a sphere of practical activity shot through by willful action, power relations, struggle, contradictions, and change" (Sewell, 1999, p. 40). Within this notion of culture, learning takes place in communities of practice. Thus, learning becomes "situated" within the community, or communities, in which it takes place or what Lave (1997) called, "the situated character of learning" (p. 17). This perspective is "based on assumptions that knowing, thinking, and understanding are generated in practice, in situations whose specific characteristics are part of practice as it unfolds" (Lave 1997, p. 19).

According to Lave and Wenger (1991), an individual's participation in a specific community of practice is at first "legitimately peripheral," increasing progressively as one's level of competence increases, leading eventually to full participation and membership in the community. However, the process by which newcomers become old timers in a community of practice is by no means linear. Instead, meanings and relations are continuously negotiated in a "conflicting, synergistic structuring of activity and relations among practitioners" (Lave & Wenger, 1991, p. 56). Thus, it is also within communities of practice that culture is produced and reproduced.

The process whereby newcomers become full participants also requires that they have access to a variety of activities, information, resources, and persons within the community (Lave & Wenger, 1991). Furthermore, the interactions of persons and resources are affected by gender, race, and socioeconomics. Thus, the organization of access can promote, limit, or prevent participation and we must carefully examine trajectories of participation of the various members in a community of practice (Habrowski & Maton, 2009; Lave & Wenger, 1991; Lemke, 1997). Although full membership is to be an expected outcome of increasing participation, Lemke (1997) argued that "some communities have ways of denying women and members of other oppressed groups full membership no matter what their level of participation" (p. 42). As a result, the focus of research is no longer on the individual as the unit of analysis but on the nature of the participation of individuals in the social processes of cognitive activity (Kirshner & Whitson, 1997).

Science is an area in which although women's participation has been steadily increasing, they continue to be under-represented as full members of scientific communities (Conefrey, 2000; Eisenhart, 1994; Ferreira, 2009; Nettles & Millet, 2006; Subramaniam & Wyer, 1998). Eisenhart (1994) asserted that in spite of the increasing presence of women in scientific fields, the norms underlying most environments in science continue to be "prototypically male" (p. 193). Thus, women's participation trajectories in scientific communities of practice are of outmost importance to gender equity in science.

The study of departmental culture is particularly important to gender equity in science because graduate school marks the point in which most graduate students begin to participate in the reproduction cycle of the scientists' community (Lave & Wenger, 1991; Schuh & Kuh, 2005). Indeed, the Ph.D. thesis in science is primarily an apprenticeship in research (Conefrey, 2000; Holloway, 1993). It is during their work in a science laboratory that graduate students, as novice scientists, are socialized "into what is valued by their laboratory and by the larger community of scientists to which they aspire to belong" (Conefrey, 2000, p. 253). Often the graduate education experience is also shaped by specific situations such as the student's relationships with specific faculty (Conefrey, 2000; Ferreira, 2002). Research designs, therefore, should capture the complex nature of graduate school. Yet, few researchers have examined the various ways in which departmental culture impacts graduate student success. In this study data from a survey questionnaire and interviews with graduate students and faculty members were used to examine students' level of participation in communities of practice in two graduate science programs.

Methodology

Setting

The study took place in two graduate science departments, biology and chemistry, at a large research university in the Mid-West of the United States. The biology department offered doctoral and Master's degrees in all major areas of biology from molecular biology to ecology. The department had 177 graduate students, 43% women. Of the 48 tenure-track faculty members nine were women at various rank levels (2 of assistant, 5 of associate and 2 of full professor). The chemistry department offered Ph.D.s in all of the major sub disciplines of chemistry, from biochemistry to physical chemistry. However, students who decided to leave before completing their Ph.D. were given a Master's Degree if their work were considered to be of sufficing quality. The chemistry department had 34 faculty members, all men, 74% of them at the rank of full professor. Of the 186 graduate students in the chemistry department 30% were women.

In both departments the doctoral program was primarily based on research. Incoming graduate students were funded for a period of five years in the form of teaching and/or research fellowships. Most students taught the first year and received research assistantships when they joined a research group. After this first year, most of students' effort was utilized conducting research as members of sometimes large research groups managed by their research advisor.

Participants

The primary respondents for this study were 12 faculty members (six from each department), and 170 graduate students, 86 from biology (46 men and 40 women) and 84 from chemistry (53 men and 31 women). Of these, 32 students (16 from biology and 16 from chemistry) were interviewed. The selection of students for the interviews was done to insure a representative sample of men and women in each department representing a variety of perspectives (LeCompte & Preissle, 1993). To maximize diversity of perspectives, the selection of faculty members to be interviewed was based on age, gender (only in biology), ethnicity, rank, number of years in the department, and sub-discipline.

Data Collection

The students' perspectives on their department were obtained from their answers to 10 items on a 5-point Likert-type scale survey questionnaire, their comments to these items, their responses to an open-ended question in which they described their department to a prospective graduate student, and student interviews. Sample items in the survey include: "The level of mentoring in my department is very high," "My advisor is often available for advice and/or support," "In my class there is a lot of collaboration between male and female students." Each survey item included space for student comments.

Two other items, one addressing students' perception of their ability to handle the work required for their degree, and the other one regarding their thoughts about quitting the program, "I seldom think about quitting the program," were also part of the survey. The alpha reliability coefficient for the 10 items in the survey was .83.

Demographic items in the survey included students' major, ethnicity, gender, and marital status. Students were also asked to report the average number of hours (per week) that they spent conducting research in the lab and to rate their self-confidence level at two points in their program -- when entering graduate school, and at the time of the study.

The survey-questionnaire also included an open-ended question in which students were asked to describe their department to a prospective graduate student. Student interviews were used to clarify and/or discuss in greater depth individual student's responses to the items on the survey, and to explore additional issues/themes that emerged in their responses.

The faculty members' perspectives on their department were obtained from one interview question in which they were asked to describe their department to a prospective graduate student. The interviews were audio taped and took between 30 and 60 minutes each. Departmental records were used to determine the faculty and student composition of each department, student undergraduate and graduate grade-point average (GPA), and the student attrition rate (female and male) over a nine-year period.

Data Analyses

Analysis of variance was used to determine significant gender differences in student responses to the survey-questionnaire, their age, graduate and undergraduate GPA, and the weekly number of hours spent in the lab conducting research. Chi-square tests were used to determine significant gender differences in the student attrition rate and in their ratings of their self-confidence level before entering graduate school and at the time of the study.

The transcripts of the faculty and student interviews and of student comments to the items on the survey were analyzed using the techniques of naturalistic inquiry (Lincoln & Guba, 1985; Miles & Huberman, 1994). After the interview tapes were transcribed verbatim and students' comments to the survey questions copied, each comment was coded with the respondent's assigned code number, department and gender. As each transcript was read and categorical themes were identified, a text-based coding was used (Miles & Huberman, 1994). While categorical themes were identified, markings were made on the margins of the transcripts to code each theme (e.g., "competition"; "collegiality"; "sense of isolation"). These codes were revised and new ones added as the transcripts were read several times. The accuracy of the themes was accomplished through "member checking" and a peer reviewer (Lincoln & Guba, 1985).

Results

Statistical analyses of the data did not uncover significant gender differences in: (a) students' age, (b) their undergraduate and graduate grade point average, (c) the ratings of their incoming self-confidence level, and (d) the weekly number of hours spent conducting research in the laboratory. However, significant gender differences were found in the student attrition rate and in the ratings of their self-confidence at the time of the study. The attrition rate of female students, over a nine-year period, was significantly larger than that of males X^2 (1, N = 726) = 14.81, p = .001 and was significantly higher in the chemistry department X^2 (1, N = 726) = 12.86,

p = .000. The female students also rated their "present" self-confidence level much lower than did the males X^2 (1, N = 170) = 12.09, p = .002.

Community of Practice # 1: The Biology Department

As results in Table 1 indicate, no gender differences were identified in student responses to the survey items in the biology department. Both female and male students appeared to have a considerable positive view of their department. For example, approximately 80% of the students (female and male) agreed with statement 8 "Overall I am happy with my working conditions."

Table 1
Student Perspectives on the Biology Department: Survey Results

Statement	Females *M* (*SD*)	Males *M* (*SD*)	*t*	*p*
1. My low income is a source of dissatisfaction in my present situation.	2.59 (1.21)	2.50 (1.32)	.29	.77
2. The level of mentoring in my department is very high.	3.44 (1.21)	3.33 (1.12)	.39	.70
3. More female faculty would make the environment in my department more supportive for female students.	3.47 (.90)	3.25 (.91)	1.02	.31
4. More female faculty would make the environment in my department more supportive for male students.	3.06 (.65)	3.06 (.86)	.02	.99
5. In my department women often keep quiet because they are afraid of being labeled "troublemakers."	2.21 (1.07)	2.06 (.95)	.62	.54
6. In my department men often keep quiet because they are afraid of being labeled "troublemakers."	1.94 (.81)	2.06 (.86)	.57	.57
7. The most difficult part of my work is dealing with all the issues in my department.	2.29 (.65)	2.52 (.76)	1.47	.14
8. Overall I am happy with my working conditions.	3.88 (.88)	3.69 (1.12)	.78	.44
9. I feel I can handle the work required for my degree.	3.82 (.46)	3.78 (.53)	.55	.58
10. I seldom think about quitting the program.	3.13 (.98)	3.51 (.84)	1.93	.06

Students' positive views of their department were also reflected in their comments during the interviews and responses to an open-ended question on the survey asking them to describe their department to a prospective graduate student. Moreover, students' perspectives on their department paralleled those of the faculty as illustrated in the common themes, collegiality and diversity, identified in each groups' responses.

Collegiality

In the biology department both faculty and students perceived collegiality as the most important aspect of their department. Their comments indicated that collegiality existed within laboratories, as well as between research groups, subdivisions, and even across departments. According to a female student the atmosphere in her department "is based on cooperation/ collaboration with other people. Grades are viewed as secondary." A male student described the social climate in his department as "wonderful" and added that "all post-docs and new faculty are thrilled by the diversity of research and the extraordinary degree of cooperation, openness and discussions." Another male student pointed out that in his lab "the graduate students get along fairly well and socializing is common, particularly among cohorts. The lab is extremely friendly to both male and female students and ideas are shared openly."

The opportunity to consult with faculty members within or outside the student's sub-discipline was also viewed as an important aspect of the collegial atmosphere in their department. According to a female student, "the faculty members in my particular field are very approachable. If I have a question about something I can go to anybody and talk to him/her about what I'm doing. I've never been turned away." Collegiality was similarly reflected in faculty members' comments. According to one of them, "this is a very collegiate department. Faculty and students are on a first name basis." Another one pointed out that "being in a very friendly and interactive department [had] been very good for [him]." Faculty and students also remarked that this collegiality extended into an abundance of seminars, research clubs, and brown bag seminars. According to them "there are many opportunities to interact with other scientists, to present your work in an informal way." The high level of interaction cherished by faculty and students went beyond the department. Some faculty members were involved in research projects that included faculty from other science departments across campus. These scientists were solving scientific problems using innovative approaches that integrated the expertise of investigators in various scientific fields as indicated by the following comments from a faculty member:

> I am a core member of the faculty of a graduate center for the integration study of animal behavior, consisting of one half faculty from biology and one half faculty from psychology and neuroscience, some even from medical sciences.

Interest in Diversity

Faculty and students in the biology department believed that diversity was reflected in the organization of the department itself, which brought together a diverse group of people with different perspectives. According to a female student, "our department is different from most universities in that the biology building encompasses everyone -- evolutionary people, developmental, microbiology people, eukaryotic geneticists, and so forth, so it's very diverse." Another female student added: "The things that I really like about my department is that there is a really diverse group of people." Faculty members expressed similar opinions. One of them stated: "One thing I love about this department is that it is a broad integrated department and my research has been strongly and positively influenced by my colleagues in the other areas." The biology department's stance on diversity also permeated the individual research groups as

illustrated in the following description of his lab from a male student:

> In our lab there is a wide range of diversity both in people and in ideas. We have graduate students and post-docs from all over the world. All of us work on separate projects but enjoy working and learning from each other. Each one of us has responsibilities that benefit the lab as a whole.

The large percentage (43%) of female students in the biology department and the level of visibility that female faculty members had achieved were also viewed as evidence of their department's support for diversity and equity. According to a female student, "overall the department is very comfortable for both male and female students." Although only 19% of the faculty members were female, the fact that they had reached all rank levels contributed to students' view that gender was not an issue in their department. As a female student pointed out, "female faculty members are very visible and well respected within the department." A male student shared a similar view. According to him,

> The biology department (much more than in other schools) is a place that values females. I think that the grad students and faculty see beyond gender; I have been very impressed about the degree to which equality is manifested in our department.

Although students were impressed with their department's diversity of people and ideas, some students felt that the department was still far from having a fair representation of female faculty and of other minorities. One of the female students interviewed expressed rather well this concern:

> I think it would certainly be beneficial to the department and the graduate program as a whole to have more balance, male-female ratio, but also, representing more cultures. I think that would be especially beneficial just in terms of how people think and getting a greater diversity of perspectives.

The department's administrators were aware of the need to increase the representation of female faculty and of minority groups. Although they did not use affirmative action strategies in their hiring practices, they had implemented a number of approaches intended to attract quality female candidates and accommodate the family needs of their junior faculty. A few of the faculty members had dual appointments with their spouses and untenured faculty members could stop their "tenure clock" when faced with the birth or adoption of a child. According to a female faculty member, "many of my colleagues have small children and it's normal for us to run out of meetings to pick up our kids." She added: "I stopped my tenure clock when I adopted my son and now one of my male colleagues also did it." Another female faculty member mentioned that, "families are smiled upon." She added: "When I gave my tenure seminar I was 5 months pregnant and I felt no discrimination from anyone because I was choosing to have a family."

Some faculty members and administrators were also directly involved in increasing the representation of minority students in their department. According to the department's chairman:

> In the last two years we have tried a fellowship program to attract more minority students. In fact I've spent the last 3 years trying to get people into our graduate

> program. I have gone to meetings of the Society for the Advancement of Chicanos and Native Americans, the National Minority Research Symposium and have talked to people about this issue. We started mailing schools with large minority enrollments.

One of the faculty members added:

> I am very much involved in increasing diversity in our department. I am directing a program this summer sponsored by the National Science Foundation that focuses on how to get undergraduate minority students into research and then recruit them into graduate programs.

To this faculty member, the department's interest in issues of diversity was very much at the heart of the concept of "equity." According to him, "some people have had all the breaks while others haven't. We need to help those who haven't had breaks by no fault of them."

The Future

Although all the faculty members interviewed for this study were very positive in their descriptions of their department, some of them were somewhat concerned about the future. These faculty members believed that the biology department would be facing future challenges. According to them, the enrollment of high-quality, American, graduate students had decreased and in order to keep their high standards, the department was contemplating increasing their pool of international students. The department also appeared have difficulty keeping their best research scientists who were receiving better offers from more prestigious institutions. The department's efforts to keep its more prestigious faculty members appeared to be demoralizing and alienating some faculty members as they saw their colleagues' salaries increase because of outside offers. According to one of these faculty members:

> We should try to maintain a balance. We cater too much to some people just because they get outside offers. We may keep them for another year after increasing their salary by so many thousands of dollars but eventually they might leave. We should concentrate on those who have a sense of loyalty to the institution and the department.

In spite of these concerns, the faculty believed the future of their department looked promising and would continue to undergo positive changes. As more women and younger faculty joined the department, the progressive attitudes already visible in their department were expected to become even more prevalent. Some faculty members would like to see graduate students become more involved in various aspects of their department, including decision-making. Others hoped for a better balance between teaching and research in tenure decisions. The graduate students in the biology department shared the faculty's views on the future of their department. Some students expressed the hope for greater participation of graduate students in the various aspects of the department. According to a female student, graduate students needed to have a greater voice in departmental decisions that affected them directly.

Community of Practice #2: The Chemistry Department

Student Perspectives

As results in Table 2 indicate, the female students in the chemistry department had a less positive view of their department than their male counterparts. Five items in the survey showed significant gender differences. The female students were less likely to agree that the level of mentoring in their department was very high (statement 2) and that overall they were happy with their working conditions (statement 8). They were also more likely to agree that more female faculty would make the environment more supportive to women students (statement 3) and those students in their department (especially females) kept quiet for fear of being labeled "troublemakers" (statements 5 and 6).

Table 2
Student Perspectives on the Chemistry Department: Survey Results

Statement	Females *M* (*SD*)	Males M (*SD*)	*t*	*p*
1. My low income is a source of dissatisfaction in my present situation.	2.96 (1.29)	3.02 (1.25)	.19	.85
2. The level of mentoring in my department is very high.	2.48 (1.12)	3.59 (1.12)	4.03	.00**
3. More female faculty would make the environment in my department more supportive for female students.	4.56 (.80)	4.09 (.91)	2.18	.03*
4. More female faculty would make the environment in my department more supportive for male students.	3.56 (.93)	3.30 (.82)	1.23	.22
5. In my department women often keep quiet because they are afraid of being labeled "troublemakers."	3.07 (1.11)	2.41 (.97)	2.65	.01*
6. In my department men often keep quiet because they are afraid of being labeled "troublemakers."	2.59 (.80)	2.14 (.70)	2.53	.01*
7. The most difficult part of my work is dealing with all the issues in my department.	2.93 (.91)	2.59 (.86)	1.67	.10*
8. Overall I am happy with my working conditions.	3.52 (1.01)	4.02 (.76)	2.38	.02*
9. I feel I can handle the work required for my degree.	3.72 (.53)	3.83 (.38)	1.01	.32
10. I seldom think about quitting the program.	2.93 (1.38)	3.36 (1.20)	1.41	.16

*$p < .05$
**$p < .01$

Female students' negative views were also reflected in their comments during the interviews and in their responses to the open-ended question in the survey asking them to describe their department to a prospective graduate student. Although male students were not as negative as their female peers in their responses to the survey items, during the interviews many of them were also critical of some aspects of their department. Analysis of these qualitative data uncovered four main issues in the chemistry department: (a) lack of collegiality, (b) competition, (c) lack of diversity, and (d) issues of power.

Lack of Collegiality

Student replies to interview questions examining inter- and intra-lab collaborations indicated that although a certain level of cooperation existed within some groups, collegiality was low in the chemistry department. A female student commented about the chemistry department as follows, "it's just a total lack of collegial environment." Another female student commented that in her area of chemistry, "each lab is very much a little island; each group does their own thing. There is very little borrowing of equipment, or trying to work together." She added: "there are no interdepartmental collaborations at all."

The lack of collegiality that appeared to exist in the chemistry department limited students' perspectives to their experiences in their own research lab where students reported spending 40-65 hours a week. Furthermore, because the research advisor (or principal investigator) was the head of the laboratory, the students' relationship with their advisor framed their overall perspective of the program. In fact, there was a strong relationship between students' level of satisfaction with their advisor and their opinion of the department as a whole. The power of individual advisors in shaping the social climate in their research lab is illustrated in the following descriptions from two female students.

> The inorganic department at [this university] is very well-respected. My research advisor is very well-known and good to work for. He has a 'hands-off' approach in that he is not looking over your shoulder in the lab, but he will have you read/review articles or present papers at group meetings to get you involved in the field of chemistry. He encourages his students to take vacations and time off when needed. (*Female student one)*

> You will receive minimal feedback and support from your advisor. Intra-lab politics make it difficult to work in the group. Of the over 40 Ph.D.'s granted by the advisor in the past 25 years, only 4 have gone to women (and many more than 4 have tried). This is an important indicator of the type of environment that exists. (*Female student two)*

These two descriptions portray rather different working climates in each research lab. The first example illustrates an atmosphere of respect and fellowship among the students in the laboratory. The advisor is portrayed as a key figure in the development of this atmosphere. In the second description the advisor once again plays a key role in the sort of working environment that exists in his lab. However, instead of collaboration this advisor has fostered an atmosphere of competition. According to one of his female students, "he has used the term 'survival of the fittest,' and that's how he believes his lab should be run. That's how he believes the department should be run."

Competition

Student comments indicated that the social climate in the chemistry department was best characterized by competition. A male student described the environment in his department as a "cut-throat atmosphere." Another male student depicted his lab as "A highly competitive environment where you are constantly asked to prove yourself." Female students made similar comments. According to one of them, the environment in her lab was "Very competitive. A very independent sort of, 'you do your own thing.' Not a lot of teamwork." According to another female student, "competitiveness comes where you do what it takes to get ahead without regard for other people." Furthermore, students often mentioned their advisor as responsible for the development of such competitive atmosphere. A female student described her advisor as running "his research groups so that we compete against each other."

Lack of Diversity

The need for female faculty in the chemistry department was well recognized by both female and male students. Most of them believed the presence of female faculty members was particularly crucial to female students. As illustrated in the comments below from a female student, they needed female faculty who could serve as role models and mentors and who would help them believe in the possibility of female success in academia:

> It would help if we had at least one female professor. Because that makes you think, "what's wrong? Is there something going on here?" You don't realize that until you are actually in the department and you look around and you want someone to talk to.

Male students were empathetic of their female colleagues' situation and the effect that the lack of female faculty might have on them. When asked about the importance of having female faculty in his department a male student replied:

> I think that female students need role models even at this level. The chemistry department right now does not have a single female faculty member, and what does that tell female students?

Students did not understand their department's apparent lack of success in securing prospective female faculty members. Although some students attributed this problem to the low number of female candidates, others believed the culture of the department itself might discourage some of the candidates. According to a male student "some of the professors have very sexist attitudes. I don't know how big of a role that has played." Other students believed that the chemistry department might be searching for a specific type of female candidate -- one who would fit within the culture of the department. Those who had personally known the only successful female faculty member in the chemistry department (she had left two years earlier) believed her success was due to her "personal male characteristics in dealing with people."

According to a female student, "She was very high-powered and she didn't care whose toes she stepped on." She further noted that "the female graduate students who are the most successful are the ones who can joke with the older professors and laugh about things. That's how they get their respect because they don't act like women."

Students also believed diversity should extend to hiring minority faculty. They wondered if the low enrollments of minority students might be due, at least in part, to the composition of the faculty. The number of minority U.S. nationals was very small and although the department had a significant number of international students, most of them were European. A female student remarked:

> For a chemistry department, we have very few Asians compared to other chemistry departments and practically no African Americans. I would have to say that if you're an European international, you're going to fare much better than if you were of Asian or African descent.

A male student expressed of similar opinion:

> I look around in my graduate program and we have pretty much white males and females, mostly males, and there aren't a lot of minority students, and I wonder if that has to do with the fact that the faculty members are all white males.

Issues of Power

Just as the individual professors set the tone in their laboratories, the department's chairman was responsible for setting the tone in the chemistry department. Indeed, students attributed the negative climate in their department, at least in part, to the department's chairman. According to a male student the department chairman "has a big ego." The same student added: "Very few women leave with a Ph.D. under his supervision, although many join his group."

The department chairman's demeanor also added to the sense of isolation that some students were experiencing. When a female student was asked if the department's chairman was aware of the issues that females students were experiencing in the department a female student replied:

> The chairman has the reputation of being quite a bastard. If I had a problem, there's no way I would ever go to him about it because he would be the last person that would back me up.

Faculty members and students also perceived the department's chairman as having a significant amount of power in any issues regarding the chemistry department. This power was particularly visible in tenure decisions. According to a faculty member, the department's chairman had the last say on whether or not a junior faculty member was awarded tenure. When discussing a recent controversial incident, in which a junior faculty member was denied tenure, a male student commented:

> I'm sure that a lot of political things happened, although in this case funding was used as an excuse. This guy was excellent; everybody liked him and he got along with everybody. As a matter of fact, this guy was an excellent teacher, his research was moving along very quickly and he was a prolific writer and got a lot of publications. He won the tenure vote, but at the last minute the chairman vetoed it.

According to the students some of the senior faculty members also had a considerable amount of influence in departmental matters, including tenure decisions as illustrated in the comments from a male student:

> As far as gaining tenure here I know that we've had several faculty members that haven't gained tenure recently and the rumors go that's because they didn't really tow the line. I think they were a little bit too progressive, a little bit too outspoken and their viewpoints didn't follow those of the more senior faculty around here.

Faculty's Perspectives

Department ranking. Analysis of the faculty interview data in the chemistry department identified one major theme: the importance of the national ranking of their department. The following comment reflects most of the responses from those interviewed: "We are number 1, 2, 3, or 4 in the country in some people's estimation. This allows us to get the "'cream of the crop.'" The importance placed in the ranking of the department was visible in the high scrutiny and pressure to achieve that new faculty members experienced. The department awarded tenure to about one third of its assistant professors. Some faculty members seemed to pride themselves on the poor tenure record of their department and used it as additional evidence of their department's high status. When asked about possible reasons for the low success rate of junior faculty in achieving tenure, a senior faculty member replied:

> They don't have a sense of commitment and don't want to achieve at a very high level. This university is interested in giving tenure to people who are internationally recognized scientists. Obviously if someone says, "I am going to take time off; I'm not going to publish this year because I am going to do something else" -- it might be a guy who decides to go canoeing or a female who decides to have a baby -- either way, they lost a whole year of productivity.

Their concern for maintaining the high ranking of the department prevented them from taking any action, such as hiring couples or women who wanted families. When asked about some innovative approaches, such as dual appointments, that could facilitate the hiring of married female candidates, a faculty member replied:

> The dean is concerned about the ranking of the department, which would certainly go down once you start hiring people as couples, because one of them is going to be inferior to the standard you would like to maintain. You would look at grants and the quality of papers published and the average of the quality of the department would go down.

The unwillingness to do anything that may affect the ranking of their department was also illustrated in the lack of active involvement in other areas related to diversity. The argument "lack of qualified applicants," was used to justify the absence of female faculty as well as the small number of minority graduate students. According to a faculty member "the number of female applicants is very small." When questioned about the low enrolment of minority students the same faculty member replied: "We have one oriental, no blacks, one Spanish. I am aware of

this. I also look at the list of applicants. It's hard to find minorities." Yet, when asked about initiatives that could be used to increase the presence of minorities in the department the same faculty member replied: "None that I know of."

The future. Maintaining the high ranking of their department in the future was the main concern of the faculty members interviewed. When asked if any aspects of the department would change in the future, the following reply reflects most of the responses of the faculty members:

> No, it can't because schools like this one are based on the tradition of being excellent in the sense that you hire only those faculty members who are internationally super stars who have access to a lot of federal grant money. After all, salary and promotion are based on research grant dollars and outside offers; it's not teaching or service.

Most students too, did not foresee any significant changes in the existing culture of the chemistry department. Although a large percentage of the faculty would be retiring in five to ten years, students believed the department was taking the necessary measures to perpetuate the existing culture as illustrated by the comments from a male student:

> Anytime someone comes in as a candidate they give a seminar, so you can kind of keep tabs on who the potential hires are and I don't see any trend, any kind of preference being given to minorities or women. So, I don't feel there is any reason to believe they're going to change very much.

A female student had a similar opinion:

> They had openings for a few new people and they hired two new male faculty members in the analytical department and they don't seem any different than the older faculty. I was kind of hoping that the new people, since they were younger, would have new attitudes, but it doesn't seem like they do.

Discussion

Lave and Wenger (1991) proposed that "learning is a process of participation in communities of practice, participation that is at first legitimately peripheral but that increases gradually in engagement and complexity" (p. 17). For most students in science, graduate school marks the point in which they begin to participate in a community of practice and in the reproduction cycles of the scientists' community (Lave & Wenger, 1991). However, the reproduction processes of the two communities of practice illustrated in this study varied greatly. The community of practice in the biology department was more "progressive/democratic," which resulted in greater "changing forms of reproduction" (Lave & Wenger, 1991, p. 115). This was evident in the common themes, collegiality and diversity, identified in students and faculty members' perspectives on their department.

In the chemistry department no common themes were identified in student and faculty responses and students' answers reflected absence of descriptors such as collegiality and diversity, which would have facilitated participation in their community of practice. Tinto (1993) found that a collegial environment was crucial to the successful integration of new graduate

students into their department culture. This integration was facilitated by the student's relationship with colleagues and professors, especially, the student's research advisor.

Diversity also facilitates integration of novices into their community of practice. As Milem (2000) pointed out, "students who interact with peers of different backgrounds or who take courses with diversified curricular content show greater growth in their critical thinking skills than those who do not" (p. 28). These students also rate their educational experiences more satisfactorily and are better prepared to function in an increasingly diverse workplace and society.

Integration and participation in communities of practice is also facilitated by those in leadership positions. Research in organizational culture suggests that effective organizational leaders are culture builders (Peterson & Deal, 1998; Prestine, 1993; Schein, 1992). In the biology department the administration had played an important role in the development of the progressive atmosphere that existed in their department. They had implemented measures such as dual appointments and postponing of tenure to facilitate the success of junior faculty, particularly those with young families, and were actively involved in increasing minority student enrolment.

The changes in the biology department were also facilitated by the high visibility of female faculty and an almost 50/50 ratio of female to male students which helped bring women's issues to the forefront. Researchers contend that areas in which women have reached a "critical mass," the environment is much more hospitable to women. "Critical mass" is defined as "the discrete point at which the presence of a sufficient number brings about qualitative improvement in conditions and accelerates the dynamics of change" (Etzkowitz, Kemelgor, Neuschatz, Uzzi, & Alonzo, 1994, p. 51). Hence, reaching a critical mass implies that the members of an underrepresented group have climbed the various levels of the hierarchical ladder of an institution or organization (Waxman, 1992). This was evident in the biology department where even though only 19% of the faculty members were women, they had reached all rank levels and were, as a result, in a position to affect their department's cultural norms. Researchers have found a direct relationship between the quality of the climate in science departments and the proportion of women faculty and students (Dresselhaus, Franz, & Clark, 1995; Sonnert & Holton, 1996).

The assumption that a culture's most important beliefs are consensual, agreed on by virtually all society's members, is contested in the concept of culture as practice. Contemporary scholars are aware of the different areas of "resistance" by subordinated groups based on gender, race, ethnicity and class. However, areas of resistance did not appear to exist in the chemistry department. Female students left in silence, aware that even after leaving, their advisors held much power over them – the decision of whether or not their work was deserving of a Master's degree and letters of recommendation needed in job seeking applications or applications to other programs/universities. Their small numbers in most labs and the lack of interlab collaborations led to a sense of isolation which was compounded by the feeling that there was no one in the department to turn to, including the department's chairman.

Many of the graduate students in this study left their community of practice before becoming full participants. Issues of gender limited many female students' legitimate peripheral

participation and prevented them from ever reaching "roles of expert performances" (Lave & Wenger, 1999, p.17). This was particularly evident in the chemistry department where "much cultural practice [was] concentrated in and around powerful institutional nodes" -- the department's chairman and some of the senior faculty (Sewell, 1999, p. 56). Indeed, the department's administration appeared to be doing whatever possible to maintain the existing culture. This was most evident in the lack of female faculty members and poor tenure record of junior faculty. Although the senior faculty members believed these measures were necessary to maintain the high ranking of the department, students felt the existing culture benefited only those in power.

Culture is a social construction. It is created and changed through the interactions and activities of people over time. However, for change to take place, new ideas must infiltrate an existing culture and be given the opportunity to take root. In academia tenure and promotion imply power and unless women and minorities reach the upper ranks of the professoriate their presence will have little impact on an institution or department's existing culture. Thus, it is critical that we examine carefully trajectories of participation of the various members in a community of practice because "some communities have ways of denying women and members of other oppressed groups full membership no matter what their level of participation" (Lemke, 1997, p. 42).

References

Aguirre, A. Jr. (2000). *Women and minority faculty in the academic workplace: Recruitment, retention, and academic culture*. San Francisco, CA: Jossey-Bass.

Berg, H. M., & Ferber, M. A. (1983). Men and women graduate students: Who succeeds and why? *Journal of Higher Education, 54*(6), 629-648.

Cohen, S. (1993). *Academia and the luster of capital.* Minneapolis, MN: University of Minnesota Press.

Cole, M.. & Engestrom, Y. (1993). A cultural-historical approach to distributed cognition. In G. Salomon (Ed.). *Distributed cognitions: Psychological and educational considerations*, (pp. 1-45). Cambridge: Cambridge University Press.

Conefrey, T. (2000). Laboratory talk and women's retention rates in science. *Journal of Women and Minorities in Science and Engineering, 6*(3), 251-264.

Dresselhaus, M., Franz, J., & Clark, B. (1995). Update on the chilly climate for women in physics. *The American Physical Society Committee on the Status of Women in Physics Gazette, 14*(1), 4-9.

Eisenhart, M. (1994). Women scientists and the norm of gender neutrality at work. *Journal of Women and Minorities in Science and Engineering, 1*(3), 193-207.

Etzkowitz, H., Kemelgor, C., Neuschatz, M., Uzzi, B., & Alonzo, J. (1994). The paradox of critical mass for women in science. *Science,* 266, 51-54.

Folch, M. T., & Ion, G. (2009). Analyzing the organizational culture of universities: Two models. *Higher Education in Europe, 34*(1), 143-154.

Girves, J. E., & Wemmerus, V. (1988). Developing models of graduate students degree progress. *Journal of Higher Education, 59*(2), 163-189.

Habrowski, F. A. III, & Maton, K. I. (2009). Change institutional culture, and you change who goes into science. *Academe, 95*(3), 11-15.

Hirt, J. B., & Muffo, J. A. (1998). Graduate students: Institutional climates and discipline cultures. *New Directions for Institutional Research, 25*(2), 17-33.

Holloway, M. (1993). A lab of her own. *Scientific American, 269*(5), 94-103.

Kirshner, D. & Whitson, J. A. (1997). *Situated cognition: Social, semiotic, and psychological perspectives.* Mahwah, NJ: Lawrence Erlbaum.

Lave, J. (1997). The culture of acquisition and the practice of understanding. In D. Kirshner & J. A. Whitson (Eds.). *Situated cognition: Social, semiotic, and psychological perspectives (*pp. 17-35). Mahwah, NJ: Lawrence Erlbaum,.

Lave, J. & Wenger, E (1991). *Situated learning: Legitimate peripheral participation.* Cambridge: Cambridge University Press.

LeCompte, M. D., & Preissle, J. (1993). *Ethnography and qualitative design in educational research.* (2nd Ed.), Boston, MA: Academic Press.

Lemke, J. L. (1994). Discourse, dynamics, and social change. *Cultural Dynamics, 6*(1), 243-275.

Lemke, J. L. (1997). Cognition, context, and learning: A social semiotic perspective. In D. Kirhsner & J. A. Whitson (Eds.), *Situated cognition: Social, semiotic, and psychological perspectives* (pp. 37-55). Mahwah, NJ: Lawrence Erlbaum.

Lincoln, Y. S., & Guba, E. (1985). *Naturalistic inquiry.* Beverly Hills, CA: Sage Publications.

MacGilchrist, B., Mortimore, P., Savage, J., & Beresford, C. (1995). *Planning matters: The impact of development planning in primary schools.* London, UK: Paul Chapman Publishing Ltd.

Milem, J.F. (2000). Why race matters: The individual and institutional benefits of diversity in higher education. *Academe, 86*(5), 26-29.

Miles, M. B. & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook.* Thousand Oaks, CA: Sage Publications.

Morgan, G. (1997). *Images of organization* (2nd ed.). Thousand Oaks, CA: SAGE Publications.

Nettles, M. T. & Millett, C. M. (2006). *Three magic letters: Getting the Ph.D,*. Baltimore: The Johns Hopkins University Press.

Office of Scientific and Engineering Personnel. (1996). *The path to the Ph.D.: Measuring graduate attrition in the sciences and humanities.* Washington, DC: National Academy Press.

Peterson, K. D., & Deal, T. E. (1998). How leaders influence the culture of schools. *Educational Leadership, 56*(1), 28-30.

Prestine, N. A. (1993). Extending the essential schools metaphor: Principal as enabler. *Journal of School Leadership, 3*(4), 356-379.

Schein, E. H. (1992). *Organizational culture and leadership: A dynamic view.* (2nd ed.) San Francisco: Jossey-Bass.

Schuh, J. H., & Kuh, G. D. (2005). *Promoting student success: What department chairs can do. Occasional Paper No. 10.* ERIC Reproduction Service. ED506536.

Sewell, W. H. (1999). The concept(s) of culture. In V. E. Bonnell & L. Hunt (Eds.), *Beyond the cultural turn* (pp. 35-61). Berkeley: University of California Press.

Sonnert, G. & Holton, G. (1996). Career patterns of women and men in the sciences. *American Scientist, 84*, 63-71.

Subramaniam, B. & Wyer, M. (1998). Assimilating the "Culture of No Culture" in science: Feminist interventions in (de)mentoring graduate women. *Feminist Teacher, 12*(1), 12-28.

Tinto, V. (1993). *Leaving college: Rethinking the causes and cures of student attrition* (2nd ed.), Chicago: University of Chicago Press.

Waxman, M. (1992). Strategies for improving the representation of women in the medical sciences. *Journal of College Science Teaching, 21*(5), 293-98.

Biography

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